Precision Level Gauge

029

W. Zeiller

Precision instruments for measuring temperature, altitude and light intensity have all appeared in *Elektor Electronics*, but those of us who utilise rainwater have up to now looked in vain for a precision level gauge for our opaque rainwater tanks. All level gauge designs that have been previously published work on the basis of conductivity, which is not suitable for rainwater with its wide range of pH values. In addition, acidic rainwater converts the copper of the electrodes into green, water-soluble and poisonous copper salts. Here we present a continuously operating, accurate level gauge for rainwater tanks (and other types of containers) that brings an end to this situation.

A good level gauge is not based on the conduction of a current by the liquid, no matter what form this may take (dc, ac or pulses to prevent polarisation of the electrodes). Instead, a probe mechanically samples the position of the upper surface of the contents! With such a system, it is also possible to measure the level of a non-conductive liquid, such as heating oil. This arrangement is relatively simple (see **Figure 1**) and has the following advantages:

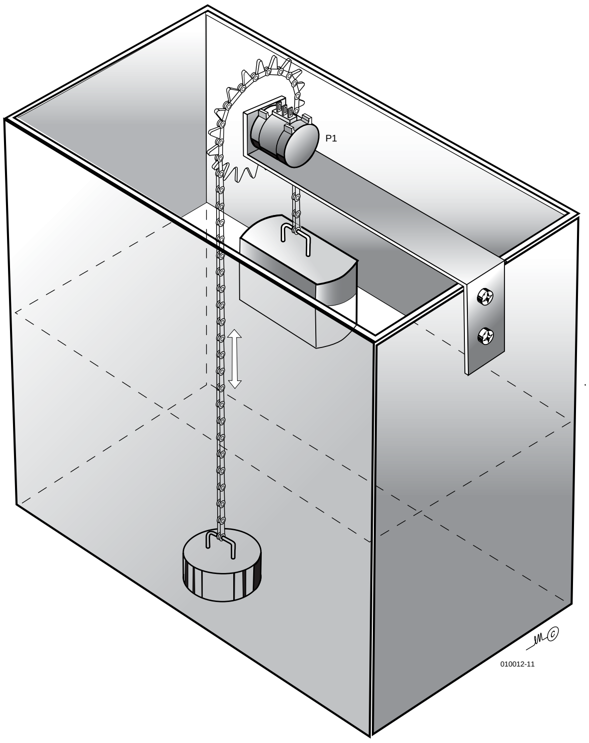
- It provides an easily sensed, continuous indication via a moving-coil meter (0 to 100%).
- A DVM can easily be connected in parallel as an indicator for a supplementary remote display.
- The power consumption is very low (e.g. 12 V × 5 mA = 60 mW), even with continuous operation.
- The level indication is accurate (for water or oil, independent of pH value and degree of contamination).
- A simultaneous trend indication is provided while the tank is being filled or emptied, thanks to the continuous display.
- Calibration is easy, with or without any liquid in the tank.

A lightweight, flexible metal or plastic band chain runs over a plastic gearwheel without slipping. A float (which may be a jam jar, for example) is attached to one end of the chain, and a counterweight is attached to the other end to keep the chain under tension. The mass of the counterweight should be around half that of the float.

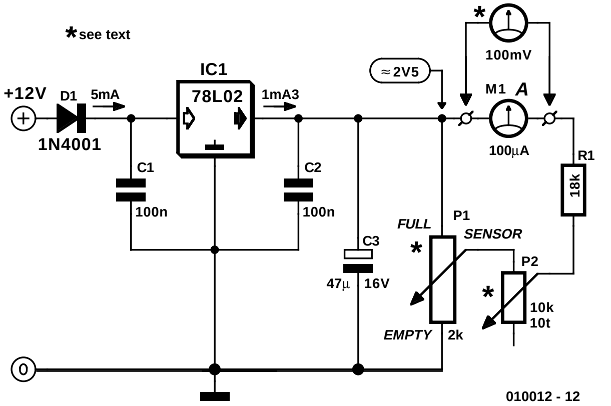
The chain will travel back and forth as the level of the liquid rises or falls. The motion of the chain alters the position of the wiper of a precision potentiometer (a 10-turn multi-turn potentiometer, Spectrol type 534), as can be seen from the circuit diagram (**Figure 2**). The voltage on the wiper (0 to 2.5 V, fixed by the 78L02) is thus proportional to the level of the liquid in the tank.

The 100-μA moving-coil meter connected to the potentiometer is used as a voltmeter instead of an ammeter. A current of 100 μA corresponds to 100% full, which makes the instrument easy to read. Due to the high resistance of the measurement circuit (P2, R1 and M1), the current consumption of the display is around 0.1 mA, which is comparable to that of a DVM. Nevertheless, the circuit satisfies the ‘linearity principle’, which states that the resistance of a load connected to a potentiometer (here with a value of 2 kΩ) must be at least 5 to 10 times greater than the resistance of the potentiometer. The internal resistance of the moving-coil meter (around1 kΩ) adds to that of the fixed resistor R1 (18 kΩ) and a portion of the variable resistor P2. This calibration resistor has to be adjusted only once so that the meter indicates a current of 100 μA with the tank

1



2



filled or the float is lifted up to the full level. Following this calibration, the 10-kΩ variable resistor can be replaced by a fixed resistor. The maximum full height depends on the diameter d of the Module 1 plastic gearwheel (40, 50 or 60 mm), since with a 10-turn potentiometer, the travel range of the float is given by $h = 10\pi d$. This yields a maximum fill height of 125, 157 or 188 cm. For secure mounting, the potentiometer should be attached to a sturdy aluminium angle bracket, which in turn is mounted on a strip of wood placed over the top opening of the tank. After drilling out the centre bore of the gearwheel from 4 mm to 6 mm, you must carefully but firmly force it over the end of the 6.35-mm diameter potentiometer shaft, which must then be oriented exactly level. The 'missing' 0.35 mm in the gearwheel inner bore ensure a secure fit to the potentiometer shaft. The band chain and gearwheels used to build the prototype were obtained from Conrad Electronics.

(010012-1)